THE UNIVERSITY OF COLORADO BOULDER

ASEN 3111: Aerodynamics
Spring 2023

SYLLABUS

Instructors:

Professor Kenneth Jansen (Lecture Instructor)
E-Mail Address: jansenke@colorado.edu
Office Hours Location: AERO 356
Office Hours Times: Wednesday 3:00-4:00 (in office),
Tuesday 11:00-12:00 (Zoom)

Professor John Farnsworth (Lab Instructor)
E-mail Address: john.farnsworth@colorado.edu
Office Hours Location: In Lab

Lecture Location: AERO 120
Lecture Time: Monday Wednesday Friday, 10:40 am – 11:30 am

Lab Time/Location:

Section 011: Tuesday, 8:30 am – 10:20 am / AERO N100
Section 012: Thursday, 8:30 am – 10:20 am / AERO N100
Section 013: Thursday, 10:35 am – 12:25 pm / AERO 141

Teaching Assistants:

Jenna Cooper
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Office Hours Location: AERO TBD
Office Hours' Time: TBD

Teaching Fellows:

Derrick Choi
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Madison Ritsch
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Web Page: Canvas (https://canvas.colorado.edu)

Course Objectives:

The primary course objective is to develop a fundamental understanding of the origins and magnitude of aerodynamic forces and moments, primarily on aircraft where they provide the lift and balance needed to fly, and to develop methodologies for modeling and prediction of such forces and moments. A secondary course objective is to develop a fundamental understanding of gas dynamics in nozzles with application to aircraft and rocket propulsion.

Learning Goals:

Establish a level of competency in the following topics such that you may use this expertise in the design of operational aircraft.

1. **Fundamentals**
    a. Vector Calculus
    b. Fluid Mechanics
    c. Aerodynamics
    d. Gas Dynamics
2. **Origins of Lift**
    a. Airfoils and Circulation
    b. Subsonic Wings
    c. Wing Sweep
    d. Supersonic Wings
3. **Origins of Drag**
    a. Skin Friction Drag
    b. Form Drag
    c. Induced Drag
    d. Transonic Compressibility Drag
    e. Supersonic Wave Drag
4. **Modeling and Prediction of Lift and Drag**
    a. Potential Flow Theory
    b. Incompressible Thin Airfoil Theory
    c. Compressible Thin Airfoil Theory
    d. Panel Methods
    e. Prandtl Lifting Line Theory
    f. Computational Fluid Dynamics

Prerequisites:

Prerequisites include APPM 2350, ASEN 2002, and ASEN 2004 with a minimum grade of C in each class. This course is restricted to Aerospace Engineering majors only.

Textbook, References, and Material:

Fundamentals of Aerodynamics, J.D. Anderson, Fifth or Sixth Edition

Course Website and E-mail List:

There will be a class website on Canvas. All relevant documents, lab assignments, schedules, and supplemental documents will be posted to this site throughout the semester. Please check back to see what has been posted. All course announcements outside of lecture and lab will be sent as Canvas announcements, so it is the student's responsibility to make sure their Canvas settings are appropriately configured to receive these announcements.

Students should only e-mail the teaching team if they have a pressing logistical or health issue. The teaching team will aim to respond to e-mails within one business day. All questions on assignments, quizzes, exams, and course content should be asked during lecture, lab, or office hours.

Course Format:

The course will follow a blend of traditional lectures and laboratory exercises. There will be a total of four computational modeling assignments. Homework will be assigned every Wednesday to be due the next Wednesday at the start of class. There will be three midterm exams throughout the semester and a final examination. Student assessment will be based on homework assignments, computational assignments, concept/reading quizzes, lab quizzes, midterm exams, and the final exam.

Grading:

Course grades will be assigned based on the following percentages:

Individual Effort:
36% Midterm Exams (3 x 12%)
24% Final Exam
5% Reading Quizzes
10% Lab Quizzes

Group Effort:
5% Homework
20% Computational Assignments

Grades will be posted to the course website on Canvas. Group Effort only contributes to the final grade if the total Individual Effort grade is C or better.

Letter Grading Scheme:

Letter grades will be assigned as follows:

Letter Grade	Percent Grade	4.00 Scale
A	93.00 – 100.00	4.00
A-	90.00 – 92.99	3.67
B+	87.00 – 89.99	3.33
B	83.00 – 86.99	3.00

B-	80.00 – 82.99	2.67
C+	77.00 – 79.99	2.33
C	73.00 – 76.99	2.00
C-	70.00 – 72.99	1.67
D	60.00 – 69.99	1.00
F	Below 60.00	0.00

Remarks on Grading:

Our grading scheme is not designed to reward or punish. It is designed to indicate your level of competency compared to the standard that we set. Do you meet the minimum level of competency? Do you exceed the minimum? Are you below the minimum? The answers to these questions should be indicated by your final grade.

The final grade indicates your readiness to continue to the next level of courses. Meeting the minimum requirements indicates that you are prepared to continue at least at the minimum level required for the next in the sequence of courses. Exceeding the minimum means you are ready to enter the next course and that you have mastery of material beyond the minimum, that is, you show some level of proficiency.

Regrading:

All regrade requests must be made within two weeks of receiving the grade for an assessment. This policy applies to homework, exams, labs, and quizzes.

Homework Policy:

Homework will be assigned every Wednesday during lecture to be due the next Wednesday at the start of lecture. **Homework assignments are due on Canvas at the start of lecture (10:40 AM) on the due date**. If you must miss class for an excused absence, you may submit your homework early. Late assignments will not be accepted under any circumstance. However, the lowest homework grade will be dropped. Each homework assignment will be worth 10 points. Homework submissions will be graded for "completeness", and solutions will be posted for self-assessment of "correctness".

Collaboration is permitted on homework. You may discuss the means and methods for formulating and solving problems and even compare answers, but you are not free to copy someone else's assignment. ***Copying material from any resource (including solutions manuals) and submitting it as one's own is considered plagiarism and is an Honor Code violation.*** Remember, the less you think about the problems yourself, the less you actually learn, and the more difficult it will be to succeed on exams.

Homework is meant both as a mechanism for students to learn and apply course material as well as practice solving problems for the midterm exams and final exam. As such, students should approach the homework assignments as if they were graded for "correctness". Students should strive to demonstrate an understanding of the principles involved by including diagrams, using

correct notation and terminology, explaining the approach, showing the key steps to obtaining the solution, and outlining the answer with proper units. Students should also submit work with a professional appearance.

Reading Quiz Policy:

There will be 4-6 random reading quizzes in lecture throughout the semester. These will be worth 10 points each. The reading quizzes will cover material assigned in readings that should be completed prior to the start of the lecture as well as material discussed in prior lecture periods. There will be no make-up reading quizzes. However, the lowest reading quiz grade will be dropped.

Lab Quiz Policy:

There will be four lab quizzes throughout the semester, one following each computational assignment. The lab quizzes will cover material associated with the computational assignments as well as material presented or discussed within the lab. The lab quizzes will be closed book, and there will be no make-up lab quizzes. If you are unable to attend a particular lab quiz due to an extraordinary situation, you must notify the laboratory instructor, via email, ahead of the scheduled time, and if an excused absence is granted, then the lab quiz grade will be dropped from your overall lab quiz grade.

Midterm Exam Policy:

There will be three in-class midterm examinations:

> *Examination 1, February 20, 2023:* Fundamentals and Potential Flow
> *Examination 2, March 10, 2023:* Incompressible Flow About Airfoils and Finite Wings
> *Examination 3, April 26, 2020:* Compressible Flow and Shock Waves

The midterm examinations will cover all material in the course including lecture, discussions, assignments, and laboratory exercises.

The midterm examinations will be closed book except for a crib sheet, and collaboration on the midterm examinations will not be tolerated. Students who are caught in these activities will receive an "F" for the course and reported Honor Code Board for further punitive action.

There will be no makeup midterm examinations. If you are unable to attend a particular midterm examination due to an excused absence, your midterm examination grade will be replaced by your final examination grade associated with the midterm material.

The course is broken into 3 primary areas that are assessed through 3 midterm exams. These same 3 areas will be tested on the final. Recognizing that testing is never an exact science, your final grade will be calculated from your best percentage of the two area tests (one from midterm, one from final) according to the following policy. When the better performance on a given area occurs on the final, the area score from the final will always be chosen which allows the final to replace any (up to all) midterm scores. However, for a midterm area to replace a lower area score on the

final, you must score at least a 70% on that area of the final exam. Thus, failing an area on the final will result in that area's score being used in the final exam score with the weighting described at the start of the Grading section above.

Final Exam Policy:

There will be a comprehensive final examination on Saturday, May 6, 2023 from 4:30 pm to 7:00 pm. The date of the final exam is dictated by the University of Colorado Boulder registrar's office and can not be changed or modified. As a result the exam can not be offered early and no make-ups will be permitted. Students are advised to plan their end of semester schedules accordingly.

The final examination will cover all material in the course including lecture, discussions, assignments, and laboratory exercises.

The final examination will be closed book except for three crib sheets, and collaboration on the final examination will not be tolerated. Students who are caught in these activities will receive an "F" for the course and reported to the Honor Code Board for further punitive action.

If you have an "A" (93 and above) midterm examination average grade going into the final examination, you may elect to not take the final examination. In this case, your midterm examination average grade would replace your final examination grade. ***Students qualifying for this option will be notified by no later than the final exam reading day, Friday, May 5, 2023***.

Computational Assignments Policy:

There will be four computational modeling assignments throughout the semester. These are:

CA 1: Computation of Lift and Drag
CA 2: Flow Over Thin Airfoils
CA 3: Flow Over Thick Airfoils and Finite Wings
CA 4: Compressible Aerodynamics

To complete these assignments, students must have access to a computer, basic programming skills, and familiarity with some programming languages and/or environments similar to what is covered in introductory computing courses. The minimum requirement is some proficiency with MATLAB. If you are not familiar with MATLAB, it is your responsibility to become so.

Collaboration is permitted on the computational assignments. You may discuss the means and methods for formulating and solving problems and even compare answers, but you are not free to copy someone else's work. ***Copying material from any resource (including code from another student or online) and submitting it as one's own is considered plagiarism and is an Honor Code violation.*** Students who are caught copying material will receive a zero "Computational Assignments" grade for the class.

For each computational assignment, a zip file containing your code must be submitted, including a "driver" or "main" MATLAB script producing all requested figures. Code must be written individually. If you have collaborated with others while designing your code, be sure to credit them

in a comment section at the top of your "driver" or "main" MATLAB script. Each computational assignment will be due on a Sunday. ***Codes should be submitted via the course website by 11:59 PM on the due date.***

Further guidelines for the code submission will be given in class.

Reading Assignments Policy:

There will be reading assignments associated with each lecture. These are to be completed before the lecture. The lecture and discussions should help to clarify and supplement what you have read.

Attendance Policy:

Attendance is expected at all scheduled lecture and laboratory periods. Expect new material to be presented in both the lecture and laboratory periods. Exams will cover all the material in the course, including lecture, discussions, homework, and laboratory exercises. All lectures and lab introductions will be recorded via Classroom Capture for asynchronous review (not live over Zoom). Quizzes will not be available to those who do not attend the lecture or lab in-person, where they are given.

Evaluated Outcomes:

The Department of Aerospace Engineering Sciences has adopted a policy of assigning grades to "evaluated outcomes" in each course:

O1: Professional context and expectations
O2: Current and historical perspective
O3: Multidisciplinary systems perspective
O4: Written, oral, and graphical communication ability
O5: Knowledge of key scientific/engineering concepts
O6: Ability to define and conduct experiments and use experimentation
O7: Ability to lead independently and find information
O8: Ability to work in teams
O9: Ability to design
O10: Ability to formulate and solve problems
O11: Ability to use and program computers

Evaluation of these outcomes allows an assessment of your performances and provides a major portion of the process we, the Faculty, use for continuous assessment and improvement of the entire AES undergraduate curriculum. The model for these outcomes derives from several sources including the *Desired Attributes of an Engineer* as defined by The Boeing Company and "curriculum reviews" from major aerospace corporations including The Boeing Company, Lockheed Martin Corporation, and Ball Aerospace Corporation. These inputs were combined with the AES faculty vision of the desired attributes of an aerospace engineer and the requirements of the Accreditation Board for Engineering and Technology (ABET) to produce this list of evaluated outcomes. Each assignment is designed and graded to assess some combination of these outcomes.

For ASEN 3111, these outcomes are grouped according to:

- Knowledge of scientific and engineering principles (O5)
- Ability to formulate and solve problems (O7, O10)
- Ability to develop and use computer programs (O11)
- Ability to design with a multidisciplinary systems perspective (O3, O9)
- Ability to work in a team (O8)
- Ability to communicate effective (O4)
- Ability to design and conduct experiments (O6)
- Ability to appreciate ethical, economic, historical, and technical context (O1, O2)

Accommodation for Disabilities:

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

Religious Holidays:

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance.
See the campus policy regarding religious observances for full details.

Classroom Behavior:

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the classroom behavior policy, the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

Requirements for COVID-19:

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. CU Boulder currently requires COVID-19 vaccination and boosters for all faculty, staff and students. Students, faculty and staff must upload proof of vaccination and boosters or file for an exemption based on medical, ethical or moral grounds through the MyCUHealth portal.

The CU Boulder campus is currently mask-optional. However, if public health conditions change and masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policy on classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus.
If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the Public Health Office (contacttracing@colorado.edu). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the Public Health Office (contacttracing@colorado.edu). In this class, if you are sick or quarantined, please send an email to the instructors alerting us to your absence. You are not required to disclose the nature of the illness or provide any doctor's note for an illness related absence.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Sexual Misconduct, Discrimination, Harassment, and/or Related Retaliation:

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, protected-class discrimination and harassment, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who believe they have been subjected to misconduct can contact OIEC at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and support resources can be found on the OIEC website.
Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of any issues related to these policies regardless of when or where they occurred to ensure that individuals impacted receive information about their rights, support resources, and resolution options. To learn more about reporting and support options for a variety of concerns, visit Don't Ignore It.

Honor Code:

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from

all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution (honor@colorado.edu); 303-492-5550). Students found responsible for violating the Honor Code will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the Honor Code website.

Prepared by: Brian Argrow, John Evans, John Farnsworth, Kenneth Jansen, and Robyn MacDonald: Last revision: January 16, 2023